Geographical Forwarding Algorithm based Video Content Delivery Scheme For Internet of Vehicles (IoV)

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ABSTRACT

An evolved form of Vehicular Ad hoc Networks (VANET) has recently emerged as the Internet of Vehicles (IoV). Though, there are still some challenges that need to be addressed in support IoV applications. The objective of this research is to achieve an efficient video content transmission over vehicular networks. We propose a balanced video-forwarding algorithm for delivering video based content delivery scheme. The available neighboring vehicles will be ranked to the vehicle in forwarding progress before transmitting the video frames using proposed multi-score function. Considering the current beacon reception rate, forwarding progress and direction to destination, in addition to residual buffer length; the proposed algorithm can elect the best candidate to forward the video frames to the next highest ranked vehicles in a balanced way taking in account their residual buffer lengths. To facilitate the proposed video content delivery scheme, an approach of H.264/SVC was improvised to divide video packets into various segments, to be delivered into three defined groups. These created segments can be encoded and decoded independently and integrated back to produce the original packet sent by source vehicle. Simulation results demonstrate the efficiency of our proposed algorithm in improving the perceived video quality compared with other approaches.

1 INTRODUCTION

Recently, further considerations were given in maintaining video streaming over vehicular ad hoc networks [1]. Utilizing Vehicle to Infrastructure (V2I) communication, a vehicle is able to download video utilizing the RSU. This was normally performed through using license-free wireless spectrum belongs to the transmission range of the RSU. In fact, it is still an open issue though RSUs are feasible to support video streaming services elaborating the license-free wireless communication technologies. This is due to the following two main challenges. Firstly, the wireless channel normally bears time-varying fading, shadowing, and interference, those consequent to high difference of link throughput and hence degrade video quality. As a second reason, the high cost that could be given in deploying RSUs to allow high coverage area in support video streaming services. Thus, it is inapplicable to install adequate RSUs to cover a complete highway. Therefore, the coverage of RSUs is irregular.

In order to address the first challenge, several approaches using the Scalable Video Coding (SVC) [2] to lighten the impact of time-varying channels that normally drawback on video Quality-of-Experience (QoE). An extension of the H.264/Advanced Video Coding (AVC) video standard, SVC encodes each video frame into layers. This was achieved by introducing a base layer and several enhancement layers. Thus, in decoding the video frames the base layer should be obtained completely. By extra enhancement layers received, a better quality of decoded video frames could be achieved. Accordingly, as an advantage of using SVC is that with some level of packets losses belong to enhancement layers are acceptable. Hence, the video receiver vehicle is able in decoding the video without obtaining all packets.

On the other hand, as a way to address the second challenge, V2V communications is a promising solution. Using V2V communications can considerably extend the coverage of RSUs along the highway. Hence, V2V allows the vehicles download video with cooperative relay vehicles. In [3] authors have organized vehicles to be into separate clusters. The way that they have used in clustering vehicles, is by managing the process of joining or leaving new vehicles. However, still there is an open issue in finding the best route to the destination or distributing the video packets among the vehicles in balanced way.

In this paper, the Quality-of-Experience (QoE) aware Geographical Forwarding Algorithm based Video Content Delivery over vehicular ad hoc networks will be considered. Certain quality metrics will be accurately measured to identify the best relay-vehicle in forwarding the video packets, which are taken in consideration the high mobility and dynamic nature of VANET. Moreover, a load balancing driven geographical forwarding for video packets is proposed to distribute them among the vehicle cooperative relay. The proposed video geographical forwarding algorithm in this study aims to minimize the video playback interruption time and maximize video playback quality with avoiding high startup delay. Thus, using our proposed video routing algorithm the users will observe an improved QoE of running video.

2 RELATED WORKS

The serious need for obtaining high QoE for the video streaming over vehicular networks has driven the research efforts towards the development of more efficient protocols. Maintain high quality of transmitted video over VANETs could enable the service of reporting fatal road accidents, which leads to obtain an improved version of IoV. Yet, this task of transmitting real-time application such as video over VANET network is a challenging. This is due to the fact that vehicles are moving in a highly dynamic and unpredictable topology, which makes the video routing protocols facing tremendous challenge. This dynamic behavior of vehicular networks topology is challenging as it consequences in frequent link disruption and a disconnection will highly occur. On the other hand, Low bandwidth, high packet loss rate, and short-lived connectivity are other concerns that need be attended in the environment of vehicular networks [20].

As an attempt to address the above-mentioned challenges, the authors in [4] have introduced a quality-aware geographical packet-forwarding algorithm from Road-Side-Unit (RSU) to Vehicles. Furthermore, when the destination vehicle (video receiver) moves from the connection link of one point of attachment to the other one, the Internet Protocol (IP) will be changed. Accordingly, the authors in [4] are also attempted IP mobility management for the seek of cultivating visual quality of transmitted video, as when the destination vehicle attend to obtain new Mobile IP address from the new visited RSU, a time will be taken to handle this process. In spite of the proposed solution in [4], further consideration should be taken of the next RSU selection as a way to avoid any possible quality, mobility and/or user preferences miscount.

On the other hand, enabling video applications for the use of traffic safety in vehicular networks using infrastructure-less setup is highly demanded. Fig 1 shows the vehicular network topology that is demonstrating this scenario. As can be seen, the radio communication range of every vehicular relay-node and multi-hop V2V would be used for packet forwarding from source vehicle V_s toward the destination vehicle V_d. Using V2V communication a free of charge video transmission can be achieved. However, this attempt yet to be widely visible due to the aforementioned reasons related to the highly dynamic topology in vehicular networks.

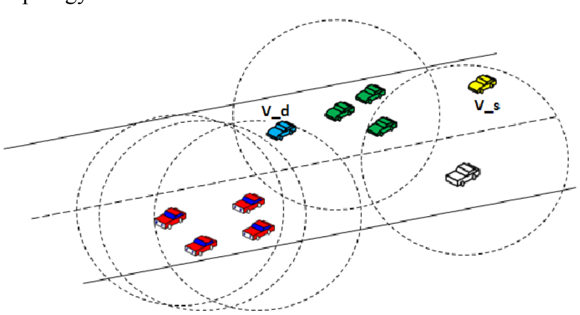

Figure 1: The highway topology of vehicular Ad-Hoc networks.

In contrast, the authors in [5] strained to improve the quality of video transmission over vehicular networks by exploring an approach to achieve a fairness of accessing the wireless channel among neighbouring vehicles. An evaluation of multi-hop video streaming from IEEE 802.11p enabled vehicular surveillance network to the traffic management center was conducted. They have employed in the evaluation phase a Scalable Video Coding (H.264/SVC) and non-standard scalable video coding three dimensional discrete wavelet transmissions (3-D DWT) [6]. As they have claimed in their study that the selection of the targeted vehicle for video transmission is crucial and it highly depends on the vehicular traffic density and location of participating vehicles. However, in their video evaluation and transmission there was no consideration of a balanced video frames routing metric considered. In other words, there should be a priority tag given for those frames (I-Frames) contributing seriously to the quality of the received video record and they should be handled view high quality relay vehicles/RSUs. While on the other side, in [7] the performance analysis of different routing protocols (AODV, DSDV, GPSR) for video transmission over realistic VANET environment is implemented. The utilized simulation tool is incorporated myEvalvid [8], NS2 [9] and VANETMobiSim [10]. The authors have concluded that DSDV is not fitting for real-time video transmission over VANET, particularly for networks with high mobility. Whilst, they have found that GPSR protocol is performing better for video transmission over VANET in comparison with AODV. They have indicated that a Pro-active type of protocols is not suitable for video transmission over VANET, and Position-based protocol is performing better for video transmission over VANET in contrast with Re-active protocol. From this claim we can also indicate that Geographical information is essential metric to be considered during the development of routing protocols for video transmission over VANET.

As another initiative to improve the video streaming over VANET, the authors in [11] have developed a method for video transmission in overlay vehicular environment. They have used joint Multi-Description Coding (MDC) [12] and spatial Flexible Macro-block Ordering (FMO) [13] as a way to save the video frames from the error-prone wireless channel. Referring to the main concept of FMO, an error resilient mechanism for H.264/AVC would be achieved. The video frames will be divided into several slices in order to cope with the lost macro-blocks of neighbor slices. Yet, this concept could not be fully on board with a scenario whereby a video frame-carrying vehicle experiencing a wireless channel quality disturbance due to some circumstances related to error rates, delay or interferences. Thus, when the essential slices of the origin video come to a relay vehicle/RSU with low offered channel characteristics, a massive distortion will be occurred on the playback video in the destined vehicle. Therefore, we could say a sensitive model/algorithm should be considered here to wisely select the next relay hope to be utilized in the video's frames forwarding process.

An attempt to study the wireless channel characteristics an evaluation based on the GloMoSim [14] simulator and additive propagation model [15] that uses a path loss model with multi-path fading was conducted in order to take into attention the signal obstruction and attenuation. The Rician fading model was considered to incorporate the multi-path interference to the vehicles communication, which comprises one line of sight and several non-lines of sight components in the received signal. The authors have interpreted from the obtained results the phenomena that different mobility models will lead to an overhead and packet loss in the vehicular networks. The main points that we want to share here are the high movement of vehicles will usually lead to for degradation with the vehicular network performance, which inquires an accurate mobility model during the evaluation of video carrier hope. Besides, when the error of the wireless channel increases, the fading factor of Rician distribution increases. As significance, the vehicular network performance is degraded, exposing the effect of multi-path fading on the performance of the network. Hence, it is important to note that during the development of a video routing algorithm, a special consideration should be given for the Geographical information (GIO) as well as the wireless channel characteristics.

Peer-to-peer (P2P) content distribution is observed to be a cutting-adage trend in vehicular networks. One of the main applications of P2P multimedia services is the vehicular Videoon-Demand (VoD), which offers edited video file to the vehicles on the road. Improvement the QoE of VoD applications is a crucial requirement. For that purpose, the authors in [1] have proposed interactive quality-aware user-centric mobile VoD mechanism for VANET (QUVoD). It is important to highlight that the QUVoD is running based on multi-homed P2P/VANET architecture and mechanisms for storing video frames, video segment retrieval, multi-path packet forwarding. Though the simulation results have shown that it performs as compared with the state-of-the-arts approaches, this kid of proposed architecture in most cases will lead for a centralized kind of solution that enables versions limitations in the large scale from.

Under other way, to develop a receiver-based packet forwarding mechanism that helps in mitigating delay of routed video packets towards destination; Rezende et al. in [17] evaluated the performance of the proposed approach for video transmission over wireless Ad Hoc networks. The authors evaluated their proposal in terms of successful delivery rate and enhancement of video transmission quality, of two erasure techniques named random linear network coding [18] and xor-based coding [19]. They have concluded that using xor-based mechanism, the bulk video file content is recovered at the receiver vehicle. From their study a recommendation was given by considering the network size, Bit rate and Mobility factors a better quality of transmitted video over wireless Ad Hoc networks.

Another efforts were given to efficiently broadcast video applications to vehicles in the urban areas. The authors in [16] have proposed Streaming Urban Video (SUV). The SUV maintains video communication based V2V. An attention was given for tuning the transmission time slot of vehicles in video forwarding progress. For attaining this objective, a graph-coloring algorithm is used to calculate the value of time slots and a group of relay vehicles that they transmitting video over a specified time slot. They have also highlighted in their proposed algorithm that considering link quality of the selected relay vehicle reflects directly to the resolution of the transmitted video over VANET.

In different attempt, in [21] a novel video source decision scheme is proposed. Cluster and Dynamic Overlay based video delivery over VANETs (CDOV) was introduced. Using CDOV scheme, nodes are clustered based on the correlation of the video requirement/supply and moving features. Though, there was a shortcoming by not take in account some effective vehicular network factors which can contribute in forward the video's frames in an optimal way to deliver them over vehicular networks.

From the given discussions in this section, we can identify there is a glaringly need for developing an efficient video forwarding algorithm in VANET environment. Therefore, in this paper we proposed a video geographical forwarding algorithm, which can maintain the video streaming among selected vehicles in balanced form to enable reporting road status for the seek of safe traffic as an application of IoV.

3 PROPOSED VIDEO GEOGRAPHICAL FORWARDING ALGORITHM (VGF) BASED VIDEO CONTENT DELIVERY SCHEME (VCD)

This study is aiming to develop a routing algorithm that can optimally forward the frames of the video file in vehicular networks. This is achieved by fairly selecting neighbour candidate vehicles to forward the packet towards the destination. The forwarding process was made based on ranking algorithm, which is performed by the video carrier vehicle. The frames are classified, based on their higher importance, as I-frames to be inserted to base layer that is denoted by tid=0, P-frames as enhancement layer 1 is identified by tid=1, and B-frames as enhancement layer 2 is classified by tid=2. Its important mentioning that in our proposed VGF algorithm a H.264/SVC method [12] was implemented in order to coding/decoding the forwarded video. Fig 2 illustrates the scenario of proposed architecture of our algorithm.

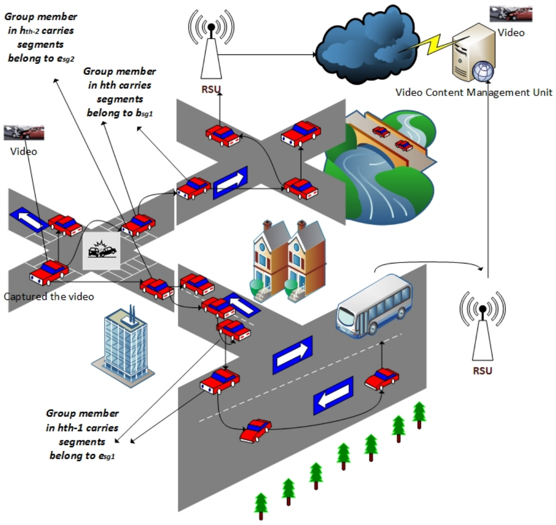

Figure 2: Proposed architecture of Geographical Forwarding Algorithm based Video Content Delivery

3.1 Enhance and Adapt Input Parameters for Reporting Video over VANET by Developing Mathematical Equations

Particularly, the video carrier vehicle ranks the neighbour vehicles based on several key important metrics. Afterwards, the most important layer, which is base layer, is forwarded to the highest ranked neighbour vehicle, the enhancement layer 1 is assigned to the second highest ranked neighbour vehicle and eventually the enhancement layer 2 is assigned to the third highest ranked vehicle. For example, the vehicles that ranked in the higher-level h_{th} will store the content of the first segment of base layer 1 b_{sg1}, the vehicles in the group second highest ranked h_{th-1} will obtain a second priority of storing the content of segmented video frames of enhancement layer 1 e_{sg1}, followed by the defined third highest ranked group of the vehicles in group h_{th-2}, holding segmented frames of enhancement layer 2 e_{sg2} , and so on.

Those video frames will then be assembled by the receiving vehicle/authority center, using H.264/SVC method [12] in decoding and playback the received video file. Accordingly, though the video stream could feel like a particular asset to the end user, which is in fact an integration of several packets (or video segments) as away to deliver the video content. The time taken in this process is proportional with the geographical distance between source and destination. As a way to facilitate the proposed video content delivery scheme, an approach of H.264/SVC was improvised to divide video packets into various segment, as was mentioned earlier. These created segments can be encoded and decoded independently. These segments can also be integrated back to produce the original packet sent by source vehicle. This enables video streaming more flexibility, particularly as several packets are needed to shape a video. It is important to mention that in our proposed scheme we introduced to replicate the video segments of h_{th} in the highest ranked vehicle that belongs to bsg1 to support delivering the high quality content of sent video whenever the content of that video is demanded by a neighbouring vehicle, the time of cashing this content will rely on the buffer size of vehicle *i*.

The ranking process of relay-vehicles was performed taking into consideration four main quality aspects. Top priority video frames that were saved in tid0 are forwarded to the vehicle achieved high rank score compared to others. Whereas, lower priorities tid1 and tid2 are forwarded to next lower ranked nearby vehicle to the top ranked vehicle accordantly. The ranking process will be made based on a developed scoring mathematical model that Considering the current beacon reception rate, forwarding progress and the geographical direction to destination, in addition to residual buffer length; the proposed algorithm can elect the best candidate to forward the frames belong to base layer followed by enhancement layers′s video frames to the next highest ranked vehicles. Thus, the video quality over vehicular networks could be efficiently improved. The following GIO and wireless channel factors are considered in developing our proposed algorithm:

Beacon Reception Rate (BRR)

As one of the main key factor that indicating the quality of neighbour vehicles is the rate of received beacons. In our proposed routing algorithm when a video carrier vehicle is in-tending to send the frames that categorized under tid0, it extracts the computed values of beacon delivery of wireless channels of the neighborhood vehicles. This can be measured by determining BRR distributed by each vehicle and then broadcast the BRR to the vehicles in the vicinity through beacon handshaking. The value of BRR is very significant as it is used in the process of neighbour selection to forward video frames towards the destination.

In fact, in order to precisely identify the accurate number of beacons that received by vehicle candidate i from source vehicle j, different factors are contributing in the determination of BRR need to be considered. For instance, BRR is normally affecting by the vehicle density in vehicular wireless network. By passing the time, the number of vehicles is fluctuating and opposite Probability of BRR (PBRR) is decreasing due to the collision phenomena, which is caused by high channel load. In the ideal channel status, the channel can go up to maximum load 1 without collisions.

A normalized vehicular wireless channel model could be formed to present the maximum or upper-bound of utilization rate of a candidate vehicle′ s channel by the time of selection in our proposed video forwarding scheme. Considering the beacon generation rate γ_g by a wireless channel and the time duration of beacon to be traveled via vehicular wireless medium TD to its destination, in addition to the number of vehicles in the range of transmission V_{no}; the value of Normalized Maximum Supported Channel Utilization Rate (NMSCUR) of vehicle *i* can be calculated in Equation 1.

$$NMSCUR = V_{no} . \gamma_g . T_D \qquad (1)$$

$$T_D = T_{(PLCP_{Header}+PLCP_{Preamble}+PLCP_{data-whitener})} + \frac{Beacon-Size}{Data-Rate} \qquad (2)$$

T_D can be modeled as follows:

Where $T(PLCP_{Header}+PLCP_{Preamble}+PLCP_{data-whitener})$ is time needed to transmit the Physical Layer Convergence Procedure (PLCP) header, PLCP preamble and PLCP data-whitener of a beacon frame. Moreover, the Beacon-Size measured by (bits) in addition to Data-Rate measured by (bit/second), are considered which reflected on the value of NMSCUR. The γ_g identifies how often per second a vehicle generates a beacon. This value directly influences the NMSCUR in Equation 4. The beacon frames considered to be generated at a fixed rate of 10 Hz or 10 beacon/second [69].

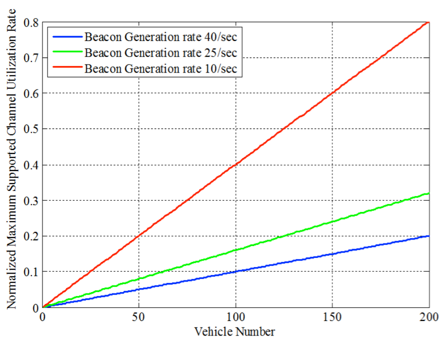

Figure 3: Normalized Maximum Supported Channel Utilization Rate with Changes in V_{no} and γ_g.

We can figure out from graphs presented in Fig 3, the behavior of NMSCUR with three different γ_g 10, 25 and 40 beacon/second rates. The highest value NMSCUR could be achieved as 0.80 with 200 vehicles when the γ_g was equal to 10 beacon/second. While it was 0.32 and 0.20 when the γg was set to 25 and 40 beacon/second respectively. The reason is that when the channel load became very high by the time of increasing the γ_g, which is leaded to drop the performance rapidly. We should note that, due to the features of radio channel, some degree of beacons might not arrive due to the high congestion rate caused by many vehicles generating beacons with high γ_g. Thus, the vehicular wireless channel can support less utilization of recourses with high γ_g and high dense network.

On the other hand, as a way to investigate more on the factors that affecting the BRR, the number of transmission slots should be also considered [70]. During each transmission slot time, (the slot time in 802.11e is 13 Micro second), a time duration normally spent which is equivalent to the duration needed to transmit a beacon, TD. When a beacon does not reach its destination within TD, this beacon will be expired and a newly beacon will be generated. The time duration of these new regenerated beacons is calculated as:

$$T_{Newg} = 1/\gamma_g \qquad (3)$$

Hence, from the previous discussion the number of transmission slots can be modeled as follows:

$$Slot_{no} = T_{Newg}/T_D \qquad (4)$$

Forwarding Progress (FP)

In our proposed video forwarding scheme when a video source vehicle is between intersections, it calculates the FP of the intermediate vehicles. This metric indicates the packet forwarding progress towards the destination and it is generally computed as a prediction of distance by Equation 5, where D_i is the distance of an intermediate vehicle to the destination and D_s is the distance of the source vehicle to the destination.

$$D_{predicted} = {}^{D_s}\!/_{D_i} \qquad (5)$$

Direction (D)

In vehicular environment, vehicles are traveling in the same or opposite directions; thus, the streets and intersections restrict their direction. Due to this bipolar movement of vehicles, vehicles that are traveling in the same direction have stable route as compared to the vehicles that they travel in opposite direction. Therefore, we consider this vehicular mobility characteristic to make the source vehicle to give higher priority to an intermediate vehicle that travel in the same direction with source. The relative direction between a vehicle and other coordinates is computed by determining the angle between direction vector of a vehicle and x-axes with y-axes.

The obtained angle degree value is limited in the range between -1 (when θ= 180, opposite side) to 1 (when θ= 0 same side). In other words, when vehicles are traveling on the highways most probably the angle degree between vehicles is either -1 (interconnection with opposite side) or 1 (same side connection), this is due to the highway-restricted direction as we mentioned before. On the other hand, when vehicles are moving in urban area the angle degree is more varied. Therefore, the obtained angle value is considered by our proposed VGF algorithm to insure the video frames that belong to base layer are forwarding to the most directed V_i to V_d.

The bearing angle (θ) between a Vd and Vi can be calculated as follows:

$$\cos\theta = \frac{V_{d_{x1}} \cdot V_{i_{x2}} + V_{s_{y1}} \cdot V_{i_{y2}}}{\sqrt{V_{d_{x1}}^2 + V_{d_{y1}}^2} \cdot \sqrt{V_{i_{x2}}^2 + V_{i_{y2}}^2}} \qquad (6)$$

Residual Buffer Length (RBL)

As a fourth ranking metric that was utilized in our VGF algorithm in forwarding the top priority video frames tid0, is the Residual Buffer Length (RBL) of vehicle candidate Vi. When a source vehicle V_s intending to elect one vehicle for forwarding the video frames, it should be aware the value RBL of intermediate vehicles, especially during the process of forwarding base layer's frames. In case a V_i has a very low RBL, this vehicle should not be chosen for forwarding process, or a less impact frames could be sent for that vehicle such as tid1 and tid2. When tid0 packets are forwarded to this vehicle with low RBL, it might be easily dropped due to full of buffer. For this reason, the RBL was considered as one of the criteria in our developed VGF algorithm.

Based on [12], the maximum Buffer Length (BL) is set to 50 packets. Hence, we set this value to be implemented into vehicles in our simulation. By the time of V_i is utilizing in video forwarding process the value of BL is varying between 0 to 50. Accordingly, we implemented in a way to make the vehicles sharing among them the up changes happening on this value frequently elaborating beaconing services. Consequently, the value of BL is calculated by each V_i as a RBL and afterward broadcasted it every time period based on γ_g settings. Thus, V_s is aware about recent RBL values of its neighbours before make the forwarding decision of top priority video frames of base layer using our VGF algorithm.

3.2 VGF-based Multi-Score Function

The proposed VGF algorithm ranks neighbor intermediate vehicles according to the above four routing metrics. But, a score function is necessary to combine all metrics in a single one. This score function favors link quality, packet progress towards destination, link stability and availability in buffer storage capacity instead of considering only a single metric for packet forwarding. We proposed the multi-metric scoring function to combine BRR, FP, D and RBL metrics.

Assume that a score function combines k routing metrics $\Gamma j = \{\Gamma j1, \Gamma j2, \Gamma j3, \ldots, \Gamma jk\}$. For each Γjk intermediate vehicles have minimum and maximum values $[\Gamma_{minjk}\ to\ \Gamma_{maxjk}]$. Thus, a multi-score function is defined as follows:

$$f(\Gamma_{j1}, \Gamma_{j2}, \Gamma_{j3}, \Gamma_{j4}, \ldots, \Gamma_{jk}) = X \times \Gamma_{j1}^{\sigma_1} \times \Gamma_{j2}^{\sigma_2} \times \Gamma_{j3}^{\sigma_3} \times \Gamma_{j4}^{\sigma_4} \ldots . \Gamma_{jk}^{\sigma_i} + SP_{max} \quad (7)$$

Where SP_{max} stands for selection probability and denotes maximum value of the score function $f(\Gamma j1, \Gamma j2, \Gamma j3, \Gamma j4, \ldots, \Gamma jk)$, X is defined as a variable that depends on the maximum value of routing metrics and weights, and $(\sigma 1, \sigma 2, \sigma 3, \sigma 4 \ldots, \sigma i)$ are denoted as weights that are used to give higher priority to a specific routing metric. In the proposed VGF algorithm, four metrics have been considered for video packet forwarding decisions. Thus, the probability value of an intermediate vehicle selection is calculated as follows:

The $f\ (BRR_j, FP_j\ , D_j, RBL_j)$ value reaches maximum when their derivative equal to zero. Thus, X is expressed as follows:

$$f(BRR_j, FP_j, D_j, RBL_j) = X \times BRR_j^{\sigma_1} \times FP_j^{\sigma_2} \times D_j^{\sigma_3} \times RBL_j^{\sigma_4} + SP_{max} \quad (8)$$

$$X = \frac{-SP_{max}}{BRR_{max}^{\sigma_1} \times FP_{max}^{\sigma_2} \times D_{max}^{\sigma_3} \times RBL_{max}^{\sigma_4}} \quad (9)$$

4 PERFORMANCE EVALUATION

In this section, the performance evaluation of our propose VGF algorithm based VCD is presented and discussed. It is important to highlight, we have implemented our proposed algorithm along with the benchmarked methods (GPRS and DSDV) using NS2 simulator. The simulation area was set to 3000 * 3000 m^2, wireless channel interfaces IEEE802.11e/p, with frequencies of 5.8 and 5.9 GHz respectively, data rate was set up to maximum 11Mbps with channel sharing based CSMA/CA, transmission power up to 33dBm and transmission rage of 250m. The video format source file is set to YUV CIF (352 x 288), MPEG-4 codecs, namely the NCTU codec. The simulated vehicles are moving with an average up to 30m/s. The simulation results are collected out of an average of 10 independent runs. Fig 4 illustrates the average PSNR obtained via the numerical analysis as well as the simulated results. PSNR is one of the common objective metric that used in evaluating the level quality of transmitted video. The PSNR was measured as the difference between a reconstructed video file and the original video trace file. Each vehicle before transmitting a video, a reference PSNR value is calculated by matching the reconstructed encoded video and the original raw video. Afterwards, when the video has transmitted, the PSNR is calculated at the receiver vehicle for the reconstructed video for any feasible damaged video sequence received. The variance between the PSNR values at the sender and receiver vehicles was used to evaluate the transmission effects on video quality at the application level. As we can observe on Fig 4, the performance of our algorithm was constructively improving while the number of vehicles is increasing in the simulated scenario.

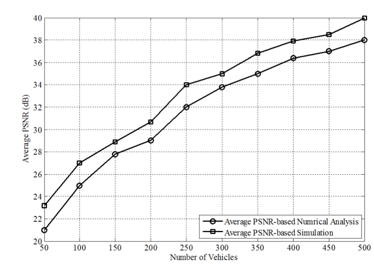

Figure 4: Average PSNR-based Simulation and Numerical Analysis with Impact of Vehicle Number.

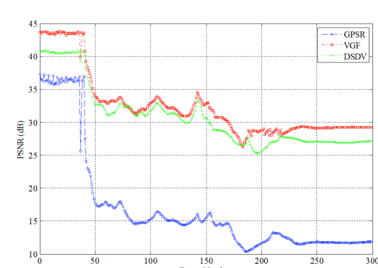

Figure 5: PSNR Comparison Obtained with Different Frame Numbers using VGF based VCD, GPSR and DSDV Routing Algorithms.

Fig 5 shows the obtained PSNR using our proposed VGF algorithm based VCD in comparison with GPSR and DSDV. It is observable that our proposed algorithm could maintain in average improved PSNR while the number of transmitted frames is increasing during the simulation time. We could relate that to the reason our proposed algorithm considering dynamically the developed evaluation metrics could improve the performance notably. Moreover, the new concept of VCD has contributed to the fact of load balancing and maintains the high priority segmented frames to get transmitted via high quality route.

4 CONCLUSIONS

In summary, we proposed Geographical Forwarding Algorithm based Video Content Delivery scheme as an initial version of an efficient video reporting approach where can assist the smart video surveillance vehicles in efficiently and instantly report road incidents and information with considering multifactor scoring function that assist in selecting relay vehicles maintain high level of QoE. In this paper the proposed architecture of our scheme was presented and discussed. Important highlighting that the video forwarding process is performed taking in account ranking the available neighboring vehicles to the vehicle in forwarding progress before transmitting the video frames using our proposed multi-score function. Considering the current beacon reception rate, forwarding progress and direction to rescuing authorities, in addition to residual buffer length; the proposed scheme could elect the best candidate to forward the video frames to the next highest ranked vehicles in a balanced way. Furthermore, a new concept was introduced in this paper that was implemented at the MAC layer of each vehicle. It helped in grouping the video frames into three categories (as was discussed in section 3) and deliver them based on the content priority to the ranked surrounding relay vehicles. Simulation results have demonstrated the efficiency of our proposed algorithm in improving the perceived video quality compared with other approaches.

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